Combined Heat and Power: U.S. Status and Overview

Ted Bronson
Associate Director
Distributed Energy Resource Center
Gas Technology Institute

Southeast CHP Initiative Meeting
Southface Energy Institute
September 26, 2002

Overview

- Introduction
- Benefits / Opportunity for CHP
- Government Commitment(s)
- CHP Market
- CHP Technology
- Market Challenges / New Thinking
- Regional CHP Initiatives and Activities
- Conclusions

The Southeastern USA

Puerto Rico

US Virgin Islands

Introduction

- Business Week #1 of 21 ideas for the 21st Century – Distributed Generation
- EIA estimates 42% Growth in Electricity Demand over next 20 years: > 400GWs
- DG provides potential to recover the waste heat
- CHP / Cogeneration / BCHP / DG / DE / DER:
- Technology Right Here Right Now!

What is CHP?

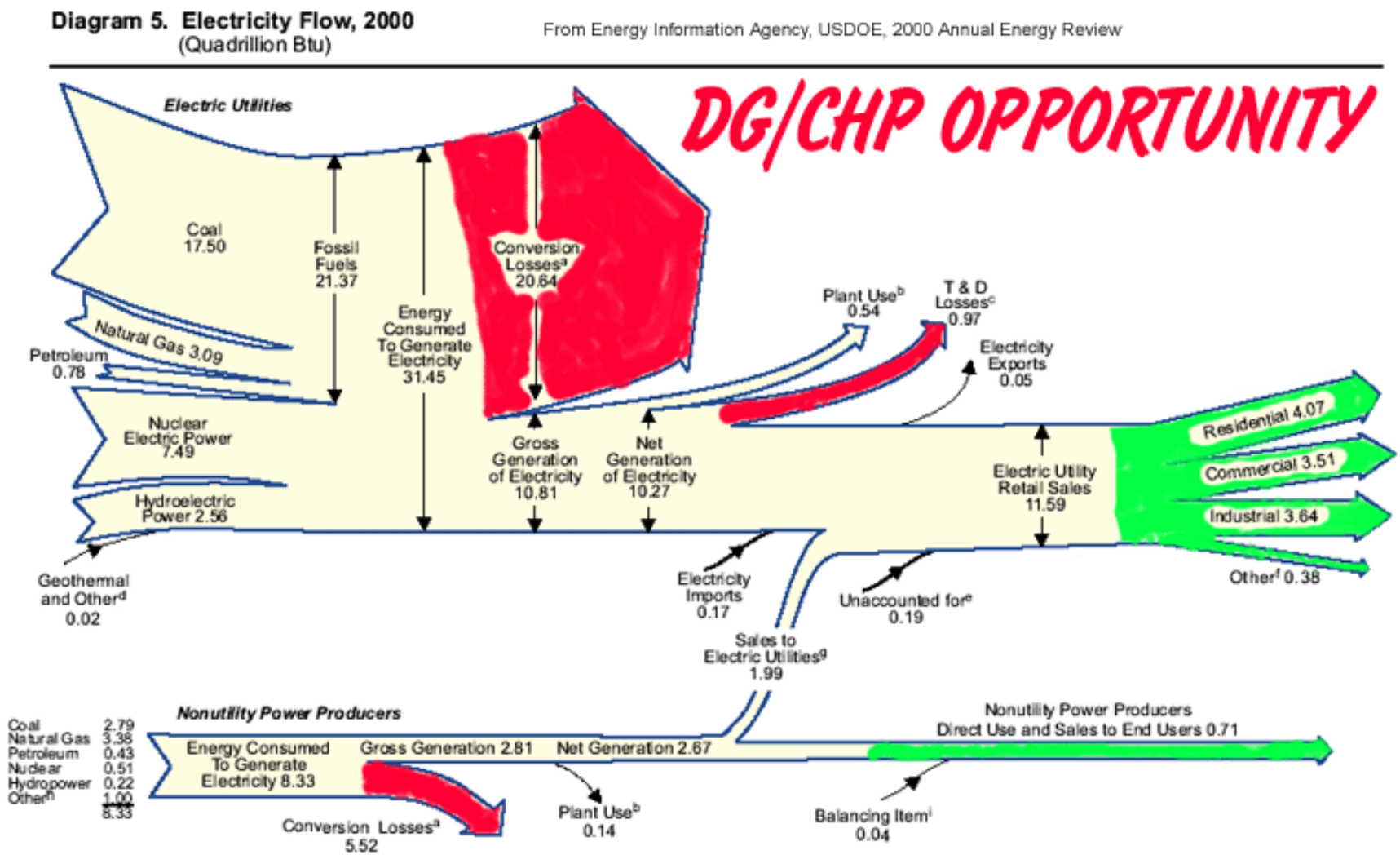
- Integrated System
- Source of Generation Located At or Near the Point of Use
- Provides a Portion of the Electrical Load
- Utilizes the Thermal Energy
  - Cooling
  - Heating
  - Dehumidification
  - Process Heat

Why is There an Opportunity?

- **Rising Concerns Over**
  - **Blackouts/Brownouts**
  - **Power Supply Constraints (Aging infrastructure)**
  - **Electricity Prices**
  - **Environment**
  - **Power Security**
- **Selected Power Outage Costs**

Industry	Avg. Cost of Downtime
Cellular Communications	**$41,000 per hour**
Telephone Ticket Sales	**$72,000 per hour**
Airline Reservations	**$90,000 per hour**
Credit Card Operations	**$2,580,000 per hour**
Brokerage Operations	**$6,480,000 per hour**

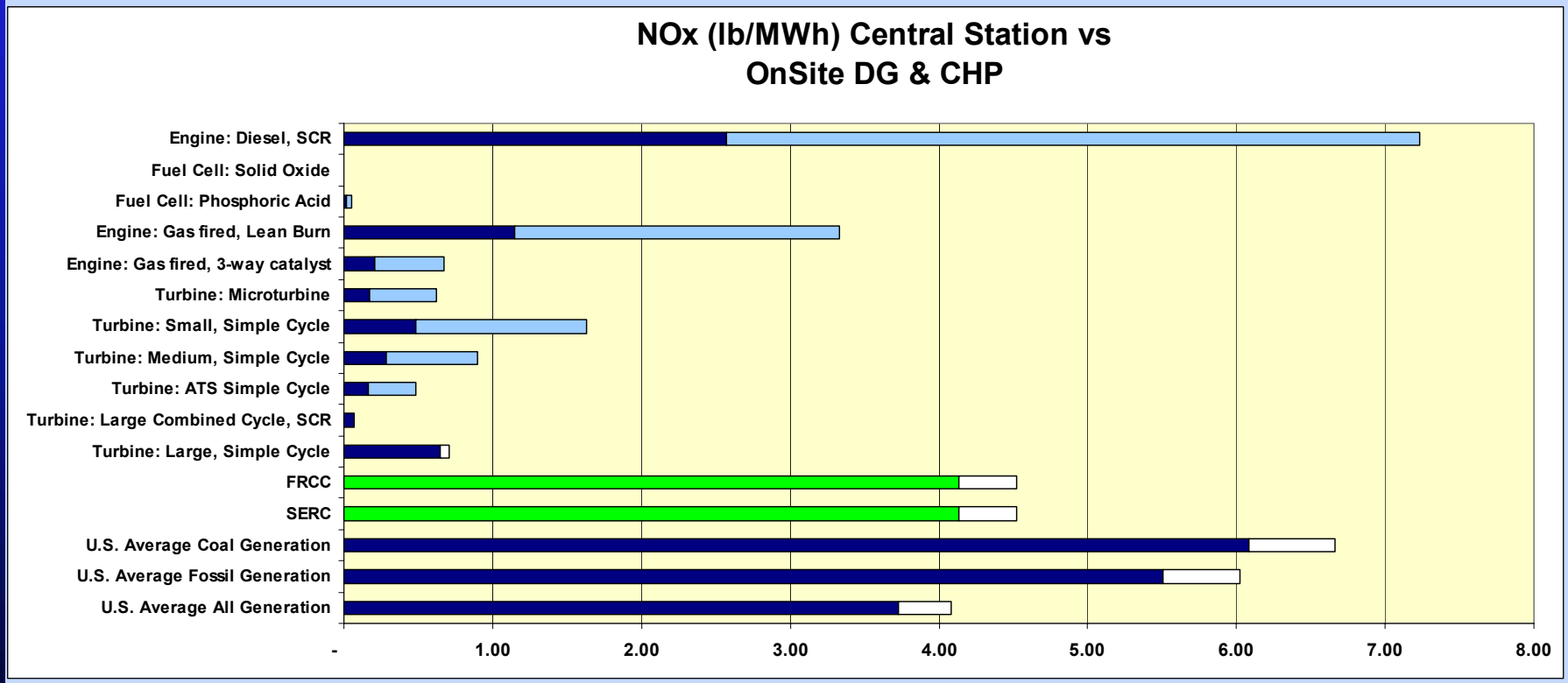
Can this be true?



Benefits of CHP

- Conservation of Natural Resources
- Addresses Environmental Concerns
  - High efficiencies currently only existing way to reduce carbon emissions and work to meet Kyoto accords
  - Output from prime mover technologies can be less than that of average emissions from central power plants
  - Facilitates deployment of new clean energy technologies
  - For buildings, can use to improve indoor air quality
- Can be used to improve grid utilization and
  - Improve end-user power reliability
  - Improve grid reliability / supplement aging areas of grid
  - Reduce peak power load demand on grid
- Lower overall energy costs

NOx & DG/CHP


NOx (lb/MWh) Central Station vs
OnSite DG & CHP
Engine: Diesel, SCR
Fuel Cell: Solid Oxide
Fuel Cell: Phosphoric Acid
Engine: Gas fired, Lean Burn
Engine: Gas fired, 3-way catalyst
Turbine: Microturbine
Turbine: Small, Simple Cycle
Turbine: Medium, Simple Cycle
Turbine: ATS Simple Cycle
Turbine: Large Combined Cycle, SCR
Turbine: Large, Simple Cycle
FRCC
SERC
U.S. Average Coal Generation
U.S. Average Fossil Generation
U.S. Average All Generation
-
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

Government Commitment

- President Bush's National Energy Policy
- U.S. DOE's CHP Challenge
  - Double CHP in U.S. by 2010
  - U.S. DOE / U.S. CHPA / U.S. EPA roadmap
- U.S. EPA CHP Partnership

National Energy Policy

- **CHP plays a major role in the National Energy Plan**
  - **Advantages:**
    - **High efficiencies result in lowering carbon emissions**
    - **Eliminates need to construct power lines**
    - **Replaces old ineffective boilers**
  - **Recommendations**
    - **Encourage EE through CHP by shortening depreciation life or providing an investment tax credit**
    - **EPA to promote CHP through flexibility in environmental permitting (EPA CHP Partnership)**
    - **Secretary of Energy to propose comprehensive energy legislation that promotes competition, protects consumers, enhances reliability, improves efficiency, promotes renewable energy, etc…**

Bush Administration, "National Energy Policy Report," May 2001

U.S. DOE's CHP Challenge

- **Double CHP in U.S. from 46 to 92 GWs by 2020**
  - **Established in 1998 under Clinton Administration with DOE and EPA**
  - **Regional and National Roadmap workshops**
    - **Over 100 industrial, environmental, and government stakeholders involved to develop roadmap**
    - **Developed detailed action plans to achieve goals**
    - **October 2000: Baltimore, Md, National CHP Roadmap**
    - **October 23-25th, 2002, Boston, Mass – National CHP Roadmap update**

EPA CHP Partnership

- Voluntary program with Industry, States, and Local governments to promote the environmental and energy benefits of CHP (www.epa.gov/chp).

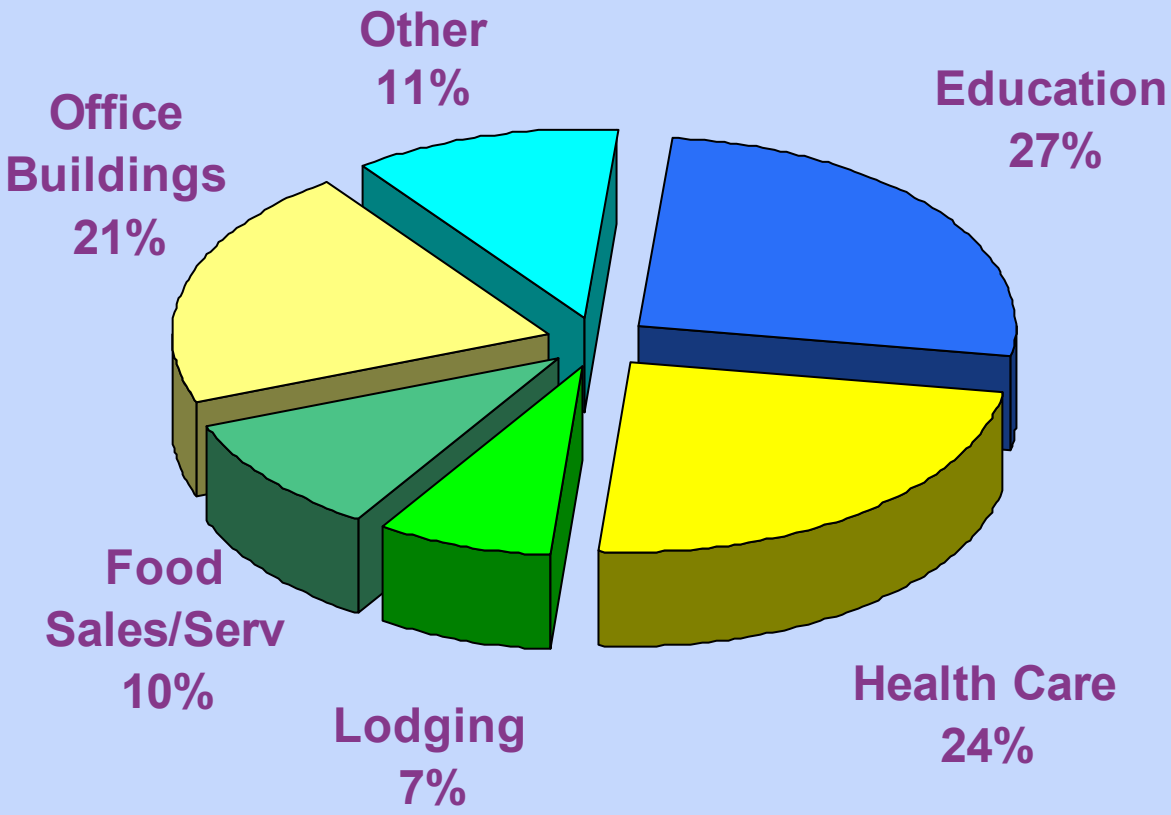
■ BellSouth	■ Verizon	■ International Paper
■ Dow Chemical	■ Texaco	■ US Steel
■ Exxon Mobil	■ Archer Daniels	■ Caterpillar
■ Solar Turbines	■ Bethlehem Steel	■ Real Energy

CHP Market

- **Industrial: Traditional CHP**
  - Approximately 1000 installations, 45 GWs
  - Average 45 MWs, Mean 25 MWs
  - Remaining Potential: 88 GWs (30 % penetration)
  - Key industries: Chemical, paper, oil refining, food, primary metals
- **Commercial: Emerging CHP**
  - Approximately 1000 installations, 5 GWs
  - Average 5 MWs, Mean, .7 MWs
  - Remaining Potential: 75 GWs (94%)
  - Key applications: Colleges, District Energy, Government, Hospitals, Solid Waste, Offices, hotels

Potential for CHP in Commercial Applications Is Large

Estimated CHP Potential: 75 GW



Source: Nexus

CHP Technologies

- Cooling Equipment
  - Mechanical Chillers
  - Absorption Chillers
  - Thermal Storage
  - Desiccant Dehumidification
- Heat Recovery Systems
  - Hot Water
  - Steam
- Electric Generation Equipment
  - Reciprocating Engines
  - Turbines/Microturbines
  - Fuel Cells

On-site Power Technologies:
Microturbines

2002
- 17-30% Efficiency (LHV)
  - 28 – 100 kW
    - Double digit ppm NO_x
      - Niche markets

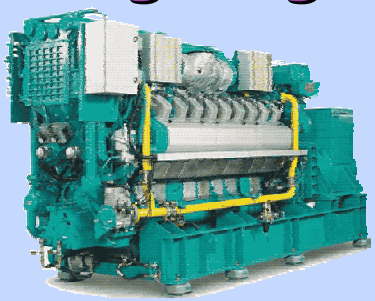
2012
- 40% Efficiency (LHV)
  - 28 – 400 kW
    - Single digit ppm NOx
      - Integrated and temperature matched IES

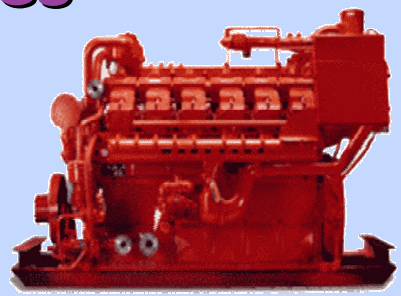
Large On-site Power Technologies:

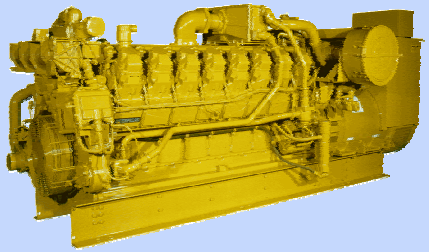
(2 to 6 MW) Reciprocating Engines

2002

- 25 - 40% Efficiency (LHV)
  2-3 grams/kWh NO_x







2012

- 50% Efficiency (LHV)
  less than 0.15 grams/kWh NOx
  Integrated jacket water and exhaust gas recovery systems for IES

On-site Power Technologies:
Advanced Turbines

2002
- 36 - 40% Efficiency (LHV)
  Prototype 3.8 MW

2012
- > 40% Efficiency (LHV)
  multiple sizes
  exhaust gas recovery
  systems for IES

Future On-site Power Technologies:

Stationary Fuel Cells

2002

- $4500 - $15,000 / kW

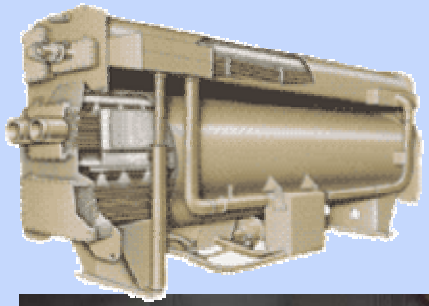
2012

- $1500 / kW

Thermally Activated Technologies:
LiBr Absorption Chillers

2002

- Good technologies, but limited penetration



2012

- Significant market penetration through 25% cost reduction 30% more efficiency and integration with IES – e.g. air cooled condensers units less than 150 RT, and temperature matching

Thermally Activated Technologies:

Desiccant Dehumidifiers

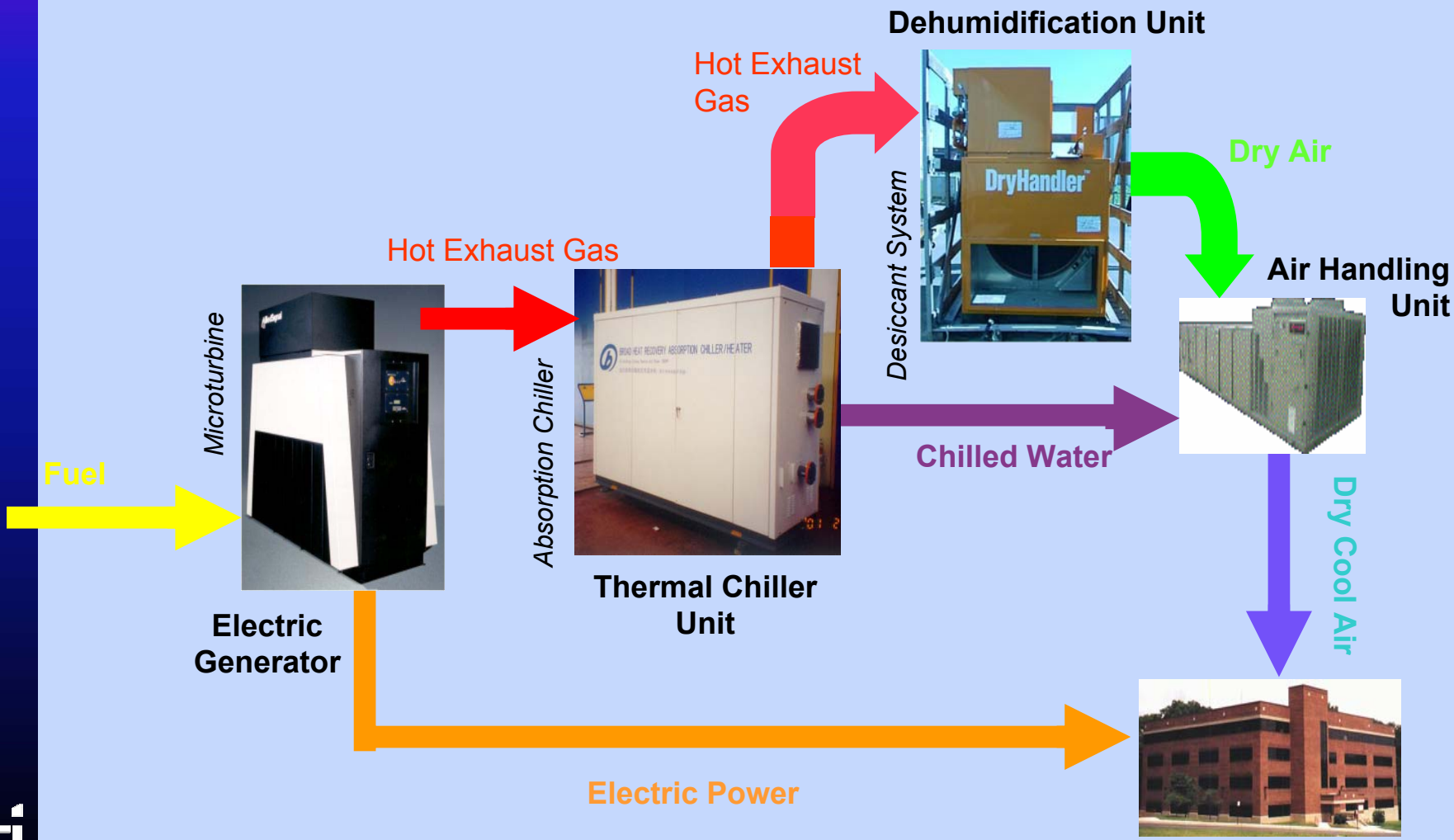
2002

- Niche market equipment for high value humidity control applications

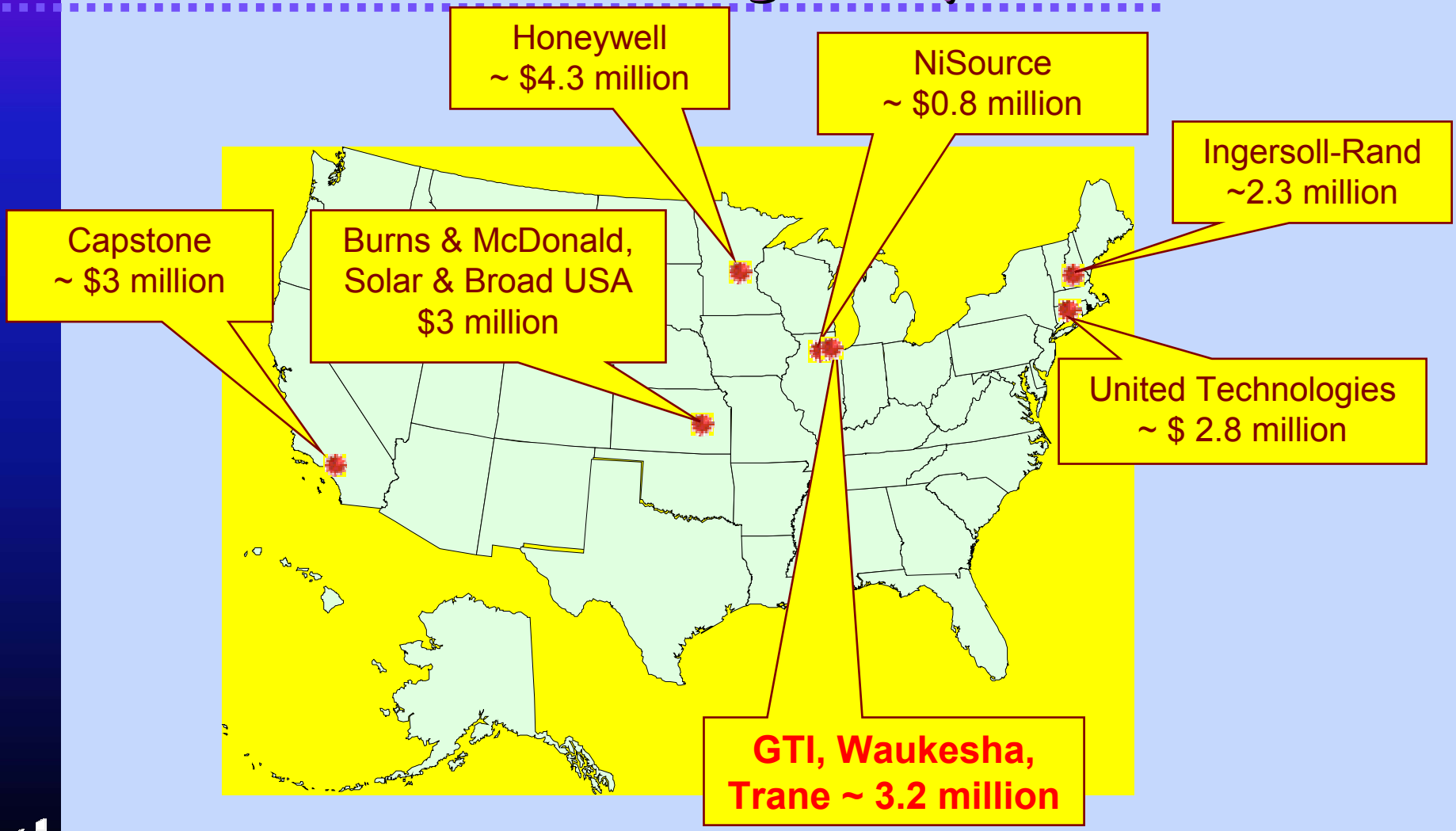
2012

- Mainstream humidity control using new solid desiccant materials & new liquid technologies resulting in 50% cost reductions

Typical Commercial CHP System



DOE Modular/Packaged System Awards



CHP Modular/Packaged System

Market Challenges

- Policy / Institutional Barriers
  - Electric Utility perceptions
  - Interconnection requirements and fees (Making Connections, IEEE P1547)
  - Tariff Structures
    - Re-negotiated rates
    - Standby Charges (discrimitory or denial)
- Education and Outreach
  - Potential end-user communities
  - Architects and Engineers
  - Electric and environmental policy makers
- Capital Cost Reduction

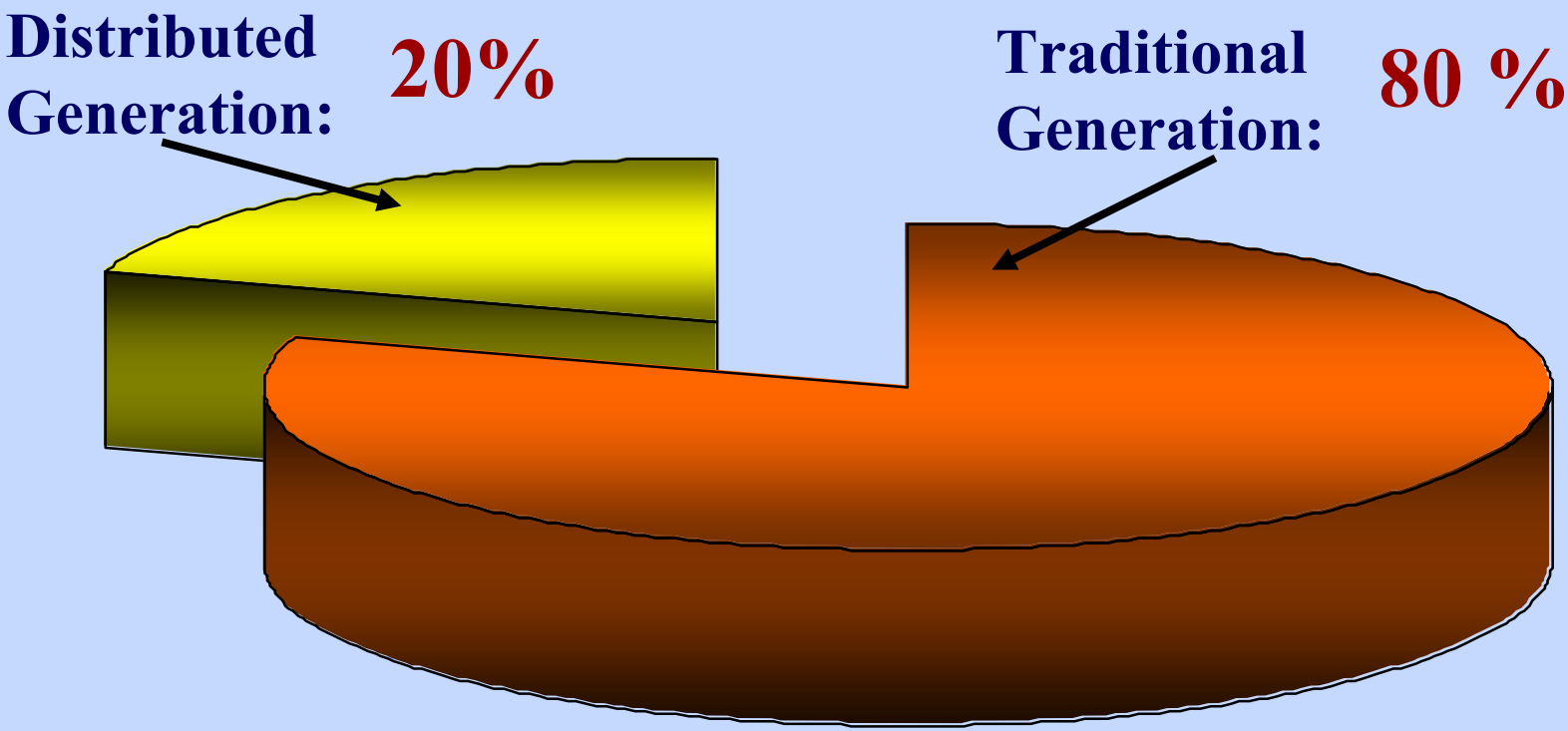
New Thinking on DE /CHP

- Answers to address myths concerning DE/CHP:
  - DE results in increased power costs for captive grid customers, most notably the poor
    - Answer: DE only represents portion of planned growth, and will serve to increase grid utilization and moderate electricity prices
  - Too much DE may cause instability to the grid
    - Answer: Recent GE study identified virtually no impact to 20%; Holland and Denmark utilizing over 40 and 50% DE.
  - DE / CHP is dirty
    - Answer: DE / CHP is not backup / standby diesel generators. See first slide on environmental benefits.

New Thinking on DE /CHP

By 2020, EIA forecasts a total of

403,000 MW new or replacement capacity



Emerging Policy Issues

- **Southern Governors' Association Resolution Regarding Transmission Pricing**
  - Urges FERC to require Transmission upgrade costs to be paid for by the customers proportionate to the benefits received
- **National Energy Bill**
  - Efforts continuing right now
  - USCHPA leading industry efforts to influence lanuguage including provisions for interconnection, net metering, and tax credits
- **FERC ANOPR on Interconnection (8/16/2002)**
  - Adoption of standard small generator (<20 MW) interconnection agreements and procedures (Docket No. RM02-12-000)
  - FERC Jurisdiction:
    - Transmission: Wholesale and Retail
    - Distribution: Wholesale
  - USCHPA again driving key policy

The Value Proposition

- CHP systems provide multiple benefits that reflect customer value streams…
- Value Proposition =

  $V_{Electric} + V_{Thermal} + V_{Reliability} + V_{Security} + V_{T\&D\ Deferral} + V_{Emissions}$ $V_{Power\ Quality} + V….$

  but we are not capturing all these values in the market place at this time.

- The trends are clear:
  - The economy will rebound
  - Energy use will increase
  - Solving Transmission bottlenecks will be expensive – raising the price of electricity
  - Distribution systems are deteriorating – repairing these systems may be cost prohibitive in some cities
  - Increasing pressure for 99.999% reliability with a system capable of 99.9% at best

Regional Initiatives and Activities

Southeast CHP Initiative

- **Mission:**
  - **Lead efforts in the Region to meet U.S. DOE's goal of doubling CHP in the U.S. by 2010 in order to:**
    - Improve the environment
    - Improve energy efficiency / conserve natural resources
    - Improve energy security
    - Enhance the areas economic viability.
- **The group will fulfill the above mission by :**
  - Leading the Region in encouraging the use of and implementation of CHP technologies;
  - Driving CHP roadmap action Items for the Southeast Region
  - Providing a central point for coordination and communication among the various stakeholder organizations in the region.
- **ACTION - ORIENTED**
- **Success may lead to DOE investment in CHP Application Center**

Summary: The CHP Solution

- CHP can present considerable benefits to environment, the electric grid, and to consumers
- Efforts needed to continue development and demonstration of CHP systems for Commercial use
  - Publicize key installations and technologies
  - Monetize benefits of reliability
  - Pricing structures may change as metropolitan grid is challenged to meet demand
- Support needed for policy changes and educational and outreach efforts through:
  - National efforts with the U.S. Combined Heat and Power Association
  - Regional efforts with the SE CHP Initiative
  - U.S. Department of Energy's Atlanta Regional Office
- Incorporate CHP goals into State Energy Plans and Metropolitan Energy Planning

Questions / Contact Info

- **Ted Bronson, GTI, Distributed Energy Resource Center**

  ted.bronson@gastechnology.org

  (847) 768-0637

- **Terri Roberts, U.S. DOE Atlanta Regional Office**

  (404) 562-0566

  terri.roberts@ee.doe.gov

- **Key websites**
  - www.nemw.org/uschpa/regional.htm#midw (MWCHP Initiative)
  - www.chpcentermw.org (MW CHP Application Center)
  - www.nemw.org/uschpa (USCHPA / National Roadmaps)
  - www.eren.doe.gov/der (U.S. DOE DER efforts)
  - www.epa.gov/uschpa (U.S. EPA CHP Partnership)